FUMIGANTS TO KILL FUNGI AND PARENCHYMA IN RED OAK LOG SECTIONS

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Methyl bromide fumigation of red oak logs (with bark) is currently used to assure that they are free of oak wilt fungus (*Ceratocystis fagacearum*) prior to export to the European Union. The rates recommended (APHIS 312 - 240g/m3) also kill the parenchyma cells in sapwood, and loss of parenchyma viability has been correlated with correct dosage of fumigant in commercial logs. Little is known of the ability of potential alternate fumigants to penetrate bark of logs of high moisture content and their efficacy against fungi and/or parenchyma cells.

Initial trials of fumigant substitutes for methyl bromide focused on eradication of the oak wilt fungus from small end-sealed sections (15cm dia.) of red oak (*Quercus rubra*) using sulfuryl fluoride (Vikane - Dow Elanco). Vikane is commonly used for insect eradication, but fungicidal reports are lacking. Replicated fumigations showed that the oak wilt fungus in the sapwood regions of the naturally infected log sections was killed at concentration x time (CT) products very similar to those required for methyl bromide:

Oak Wilt Isolation Frequency From Infected Red Oak Log Sections Following 72hr Fumigations with Surfuryl Fluoride

Vikane Rate (g/m3)	CT Product	Nonfumigated	Fumigated
160	11,280	45%*	15%
220	14,950	63%	7%
280	18,530	53%	0%

* Grand mean of 3 fumigations (300 isolations total). Full details in paper accepted for publication in *Plant Disease*.

Other fungi isolated from nonfumigated sections (species of *Graphium, Verticillium, Paeciolmyces*) as well as mycophagous nematodes were also eradicated at the highest level of fumigant treatment.

This report of fungicidal activity of sulfuryl fluoride suggests that it may merit further study for phytosanitation applications of logs and other wood products.

Subsequent study focused on the ability of fumigants to kill parenchyma cells in red oak sapwood as determined by assay using triphenyl tetrazolium chloride (TTC). Living parenchyma dehydorgenase activity turns the colorless TTC solution to a red formazan readily visible in the sapwood of thin wood chips soaked overnight. Chloropicrin and aluminum phosphide were included in addition to the Vikane in these trials on small end-sealed oak log sections:

Oak Parenchyma Cell Viability At Different Sapwood Depths Following Exposure to Three Fumigants

Fumigant	Concentration (g/m3 of chamber space)								
	55	111	150	240	255	280	500	1000	1500
Vikane			+	-	-*	-			
			+	-	-	-			
			+	-	+	-			
Chloropicrin							-	-	-
							+	-	-
							+	+	+
Al Phosphide	+	+							
	+	+							
	+	+							

* 48 hr fumigation; all others done for 72hr
Column under each fumigant concentration represents area of viable (+) or dead (-) parenchyma from just under bark (top of column) to heartwood boundary (bottom of column).

The death of parenchyma for Vikane fumigations for 72hr. was confirmed at dosage rates of 240 or 280 g/m3 of chamber space. This correlates well with that dosage confirmed to eradicate fungi from oak sapwood in the earlier trial, and suggests that such a parenchyma assay could be used as a monitoring method to assure logs had been adequately fumigated through the sapwood zone.

The penetration of fumigant generated from chloropicrin increased when dosage was increased from 500 to 1000 g/m3, but even at the 1500g/m3 level, not all parenchyma was killed as some viability by TTC assay was noted at the heartwood boundary.

The phosphine generated from aluminum phosphide did not show any effect on parenchyma cell viability at the levels tested, suggesting either limited bark penetration or lack of any phytotoxicity.

CONCLUSION: Sulfuryl fluoride would be the best fumigant for further phytosanitation trials